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(12) # EUROPEAN PATENT APPLICATION

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(54) **Transducer carriage assembly.**

(57) A carriage assembly for holding a pair of transducers 150V in contact with the opposite sides of a flexible disk 20V includes a pair of arms 302, 304 each carrying one of the transducers. A nominally flat leaf spring has the three-fold function of (1) providing a yielding connection between the two arms so that the two arms and therefore the transducers may be swung apart about this connection, (2) yieldingly holding the arms together at their places of closest approachment at which the transducers are in contact with the opposite faces of the disk and (3) providing a yielding connection between a carriage support 300 and the arms as a unit when in their closest approachment so that the arms and therefor the transducers may pivot with respect to the carriage with low frequency undulations of the surface of the disk. The transducers are each carried with respect to one of the arms by means of a normally flat gimbal spring 330 which flexes to hold the transducers in proper pressure contact with the disk and serves to absorb high frequency undulations of the disk surface.

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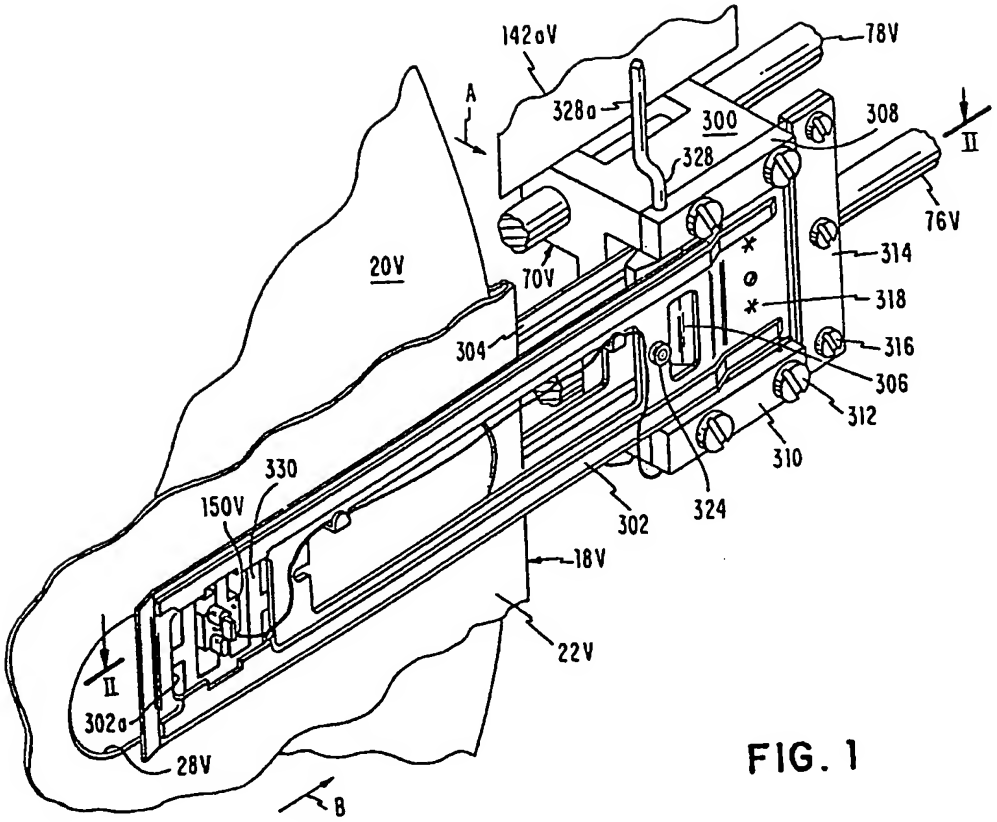

142aV
78V
A
328a
300
308
II
328
76V
20V
70V
314
318
304
316
306
312
310
330
150V
324
302
18V
22V
II
302a
28V
B

FIG. 1

TRANSDUCER CARRIAGE ASSEMBLY

The invention relates to a carriage assembly for holding a pair of transducers in contact with opposite sides of a thin flexible disk for data transfer.

It has been previously proposed in U. S. Patent 4,089,029 to provide a carriage assembly for a pair of transducers effective on a flexible magnetic disk which carriage assembly includes a gimbal spring for supporting each of the two transducers, a load arm effective on each of the transducers for moving the transducer in pressure contact with the disk and a swing arm for mounting both the gimbal spring and the load arm for each of the transducers.

It is an object of the present invention to provide an improved carriage assembly for a pair of transducers effective on the opposite sides of a thin flexible disk which is simplified with respect to the prior transducer carriage assembly.

Accordingly, the present invention provides a transducer carriage assembly for use with a rotatable flexible disk having high and low frequency surface undulations as the disk rotates, characterised by, a pair of transducers (150V, 152V), a pair of arms (302, 304) adapted to embrace the disk (20V) on opposite sides, a respective first spring means (330) mounting each transducer opposite the other at one end of a respective arm, second spring means (306) connected to the arms (302, 304) at their other ends for biassing the

said one ends of the arms together, the first and second spring means holding the transducers in effective transducing contact or near contact with opposite sides of the disk and the first spring means being effective to absorb high frequency undulations of the disk as it rotates, and means (306h) for hingedly mounting the arms with respect to a support (300) so that the arms may swing together as a unit to accommodate low frequency undulations of the disk as it rotates.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which :-

FIG. 1 is an isometric view of the transducer carriage assembly including a nominally flat leaf spring mounting a pair of transducer-carrying arms with respect to each other, a magnetic diskette being shown in an operative position in the assembly between these arms;

FIG. 2 is a longitudinal sectional view of the carriage assembly taken on line 2-2 of FIG. 1;

FIG. 3 is a side elevational view of the carriage assembly;

FIG. 4 is a side elevational view of one of the two arms of the carriage assembly and taken on line 4-4 of FIG. 2;

FIG. 5 is a plan view of the flat leaf spring, and

FIG. 6 is a plan view of a gimbal spring used in the assembly for carrying each of the transducers with respect to its respective arm.

The transducer carriage assembly 70V now to be described may take the place of the carriage 70 disclosed in U. S. Patent 4,089,029, and may be used in the data storage apparatus disclosed in that patent. Carriage 70V includes a support 300 slideably disposed on guide rods 76V and 78V which correspond with the guide rods 76 and 78 of U. S. Patent 4,089,029. The carriage assembly 70V is adapted to be used in connection with a magnetic disk assembly or diskette 18V which has a flexible magnetic disk 20V and corresponds with the disk assembly 18 of U. S. Patent 4,089,029. The guide rods 76V and 78V extend parallel with the plane of disk 20V so that the support 300 travels parallel with the plane of the disk. The disk is clamped at its centre and is rotatably driven by the clamping means as is disclosed in U. S. Patent 4,089,029. The assembly 70V includes a pair of transducers 150V and 152V which travel with the carriage 300 so that the transducers 150V and 152V move radially across and in contact with the opposite surfaces of the disk 20V.

The assembly 70V includes a pair of rigid metal swing arms 302 and 304 which are swingable apart by virtue of being mounted on a leaf spring 306. The spring 306 in its unstressed condition is flat and has a pair of longitudinal slots 306a and 306b therein so that the spring 306 has a central leg 306c and two outer legs 306d and 306e joined by a transversely extending base portion 306f (see FIG. 5). The central leg 306c has a tapered end portion 306g as shown.

The outer legs 306d and 306e are fixed with respect to the support 300 by means of a pair of fastening plates 308 and 310 held in place by means of screws 312. The legs 306d

and 306e are thus positioned in the nominal plane of the disk 20V and in the plane of the transducer faces 152aV and 150aV that contact the disk 20V in the data transferring positions of the parts as shown in FIG. 2. The arm 304 is fixed with respect to the transversely extending base 306f of spring 306 by means of a plate 314 extending over the surface of the spring base 306f and fixed with respect to the arm 304 by means of screws 316 extending through the plate 314 and spring base 306f. The arm 302 is fixed with respect to the central leg 306c of the spring 306 by means of spot welds 318 extending through aligned holes in the arm 302 and a plate 319 on the opposite face of the leaf spring 306. The tapered end 306g of the spring 306 extends through an opening 320 provided in the arm 304 so that the spring abuts against an edge 322 of this opening.

The tapered portion 306g of the spring 306, which is located between the edge 322 and the plate 319, functions to provide a force on the arms 302 and 304 yieldably pulling these arms together. This is due to the spring action of the spring portion 306g acting between the edge 322 and the plate 319 and since the spring 306 when unstressed is flat. The plate 314 is separated from the adjacent end of the arm 302 by a portion 306h of leg 306c, and portion 306h acts as a pivot to allow separating movement of the arms 302 and 304 with respect to each other.

The plate 314 has a separation with respect to the plates 308 and 310 providing intervening portions 306j and 306k of legs 306c and 306d. Assuming that the arms 302 and 304 under certain conditions have no movement with respect to each other and act as a unit, the assembly of these two

arms 302 and 304 may swing with respect to the support 300 with a flexing of the spring portions 306j and 306k.

A set screw 324 extends through the arm 302 and may abut the arm 304 so as to limit the swinging movement of the arms 302 and 304 together under the influence of the central spring portion 306g. Toggles 326 are disposed between the arms 302 and 304 for the purpose of forcing the arms 302 and 304 apart against the action of the spring portion 306g. The toggles 326 are fixed on a shaft 328 so that the toggles 326 may be rotated. The shaft 328 has an arm portion 328a outside of the support 300, and the arm portion 328a is adapted to be acted on by a lever extension 142aV which corresponds to the lever extension 142a of U. S. Patent 4,089,029. The lever extension 142aV may be moved in direction A for the purpose of acting on the shaft extension 328a so as to rotate the shaft 328 and thus rotate the toggles 326 so that the toggles wedge between the arms 302 and 304 and swing the arms 302 and 304 apart with yielding of the tapered spring portion 306g. The lever extension 142aV may be operated by an electromagnet such as is shown in U. S. Patent 4,089,029 or by any other suitable actuating means.

The arm 302 is provided with an opening 302a through it adjacent its end remote from the support 300 (see FIGS. 1 and 3). The transducer 150V is fixed with respect to the arm 302 by means of a gimbal 330 which extends across the opening 302a. The gimbal 330 constitutes a sheet of resilient metal flat when unstressed and formed generally in the shape of a figure eight and having parallel legs 330a, 330b and 330c, end legs 330d and 330e and end tabs 330f and 330g located centrally of the legs 330a and 330c and extending off of

these two legs (see FIG. 6). The gimbal 330 is fixed with respect to the arm 302 by spot welds 332. The leg 330b is provided with an enlargement 330h, and the transducer 150V is fixed to the leg 330b and enlargement 330h by any suitable bonding. The transducer 152V is fixed with respect to the arm 304 in the same manner as the transducer 150V is fixed with respect to the arm 302, using a second gimbal 330.

In operation, the arms 302 and 304 may be assumed initially to be held apart by the toggles 326. The lever extension 142aV has been moved in direction A so as to move against the shaft extension 328a and rotate the shaft 328 through nearly 90° about its journalling between the support 300 and the plates 308 and 310. This rotation of the shaft 328 has rotated the toggles 326 accordingly so that they have swung the arms 302 and 304 apart about the spring portion 306h as a pivot between the arms and against the spring action of the tapered spring portion 306g. The transducers 152V and 150V are fixed with respect to the arms by means of the gimbals 330, and the transducers 152V and 150V have thus been moved apart. The magnetic disk assembly 18V is then moved in direction B into its position between the arms 302 and 304 as shown in FIG. 1. The radially extending slots 28V in the two thicknesses of the jacket 22V are then in position between the swing arms 302 and 304 so that the transducers 152V and 150V may be applied onto the two surfaces of the disk 20V.

The lever extension 142aV is then moved back into its original position, allowing the shaft 328 and the toggles 326 to move back into their original positions. The arms 302 and 304 then swing together under the action of the

spring portion 306g which is clamped flat against the inside surface of the arm 302 by the plate 319 and, in tending to return to its flat unstressed disposition, bears against the edge 322 and thus tends to move the arm 304 toward the arm 302 to swing the arms together. The spring portion 306h between the arm 302 and the plate 314 functions as a pivot to allow this swinging movement of the arms 304 and 302 toward each other. The setscrew 324 moves into contact with the arm 304 and holds the arms 302 and 304 to their positions of closest approachment under action by the spring portion 306g. With this approaching swinging movement of the arms 302 and 304, the arms 302 and 304 embrace the disk 20V and the transducers 150V and 152V move together except for the existence of the disk 20V between them so that the active transducer faces 150aV and 152aV bear on the opposite surfaces of the disk 20V for a data transferring action between the transducers and disk. The gimbals 330 are flexed somewhat out of flatness so that the gimbals 330 hold the transducers 152V and 150V in somewhat forceful contact with the disk 20V. With the setscrew 324 in contact with the arm 304, the arms 302 and 304 are in effect fixed with respect to each other so that they may function as a unit or an assembly; and swinging movement of the arms 302 and 304 and of the transducers 150V and 152V may take place with respect to the carriage 300 with flexing action of the spring portions 306j and 306k. This swinging movement of the arms 302 and 304 is with relatively low undulation frequencies of the disk 20V and with the spring portions 306j and 306k, which are flat when unstressed, acting as hinges with respect to the arms 302 and 304 functioning as a unit. If the undulation frequencies of the disk 20V due to its rotation are relatively high so that the inertia of the arms 302 and 304 is too great to

allow this swinging movement of the arms, the gimbal springs 330 in this case flex to take up the high frequency undulations of the disk 20V, with the transducers 150V and 152V remaining in contact with the disk 20V. The transducers 150V and 152V thus remain in substantially uniform pressure and contact with the disk 20V even though the disk 20V may undulate out of its nominal plane during its rotation.

Advantageously, therefore, the single leaf spring 306 performs the three following different functions:

a. The tapered central portion 306g of the spring 306, in being clamped flat against the inside surface of the arm 302 and bent out of its flat unstressed disposition by bearing on the edge 322 of the arm 304, provides the closing force for the arms 302 and 304 to move the setscrew 324 into contact with the arm 304.

b. The spring portion 306h between the plate 314 and the adjacent end of the arm 302 acts as a pivot to allow swinging movement of the arms 302 and 304 with respect to each other and effectively ties the arm 302 and 304 together.

c. The spring portions 306j and 306k between the plate 314 and the plates 308 and 310 function to allow the swinging movement of the arms 304 and 302 as a unit with respect to the carriage 300. The setscrew 324 under these conditions remains in contact with the arm 304 so that the arms 302 and 304 function as a unit and swing together. The spring portions 306j and 306k are

flat in unstressed condition so that they act as hinges and allow this swinging movement with a minimum of restraint and with equal return forces in the two directions of return. Since the outer legs 306d and 306e, by means of which the arms 302 and 304 are attached to the carriage 300, are spaced, the assembly of the arms 302 and 304 and of the transducers 150V and 152V is held from movement from the horizontal, assuming that these arms 302 and 304 initially extend horizontally and that the plane of the disk 20V is vertical.

The single spring 306 thus performs a multitude of functions and thus is a principal part of the relatively simple transducer carriage assembly disclosed. Since the arms 302 and 304 may swing as a unit with flexing of the spring portions 306j and 306k, the transducers 150V and 152V may follow coarse or low frequency undulations of the disk 20V normal to the nominal plane of the disk 20V; and the structure thus provides a stable compliance and balanced pressure of the transducers with respect to the disk for reliable data transfer and for reducing wear either on the disk or on the transducers, even with warped or offset disks. The swing arms 302 and 304 functioning as a unit or assembly, with the setscrew 324 in contact with the arm 304, thus function as a kind of "course" aligner of the transducers 152V and 150V for warped or offset disks 20V, and the gimbals 330 themselves function as a sort of "fine" aligner for the transducers on the disk for absorbing fine or high frequency undulations of the disk 20V normal to the nominal plane of the disk 20V. The gimbals 330 being made of spring

metal or the like provide the proper application pressure of the transducers 150V and 152V on the disk 20V without the necessity of using auxiliary load arms or beams for this function and are self-loading. Their use results in a small number of parts and a low cost, considering the various requirements of the system.

It may be noted that the spring portions 306j and 306k about which the arms 302 and 304 move when functioning as a unit, are located nearly as remotely as possible from the transducers 152V and 150V and are in the plane of the disk 20V (see FIG. 2 in particular). This arrangement yields an advantage in better and consistent track registration as a function of the deflection angle of the arms 302 and 304 from their normal dispositions parallel with the nominal plane of the disk 20V as the disk wobbles and has runout, in comparison with many prior designs of carriage assemblies.

CLAIMS

1. A transducer carriage assembly for use with a rotatable flexible disk having high and low frequency surface undulations as the disk rotates, characterised by, a pair of transducers (150V, 152V), a pair of arms (302, 304) adapted to embrace the disk (20V) on opposite sides, a respective first spring means (330) mounting each transducer opposite the other at one end of a respective arm, second spring means (306) connected to the arms (302, 304) at their other ends for biassing the said one ends of the arms together, the first and second spring means holding the transducers in effective transducing contact or near contact with opposite sides of the disk and the first spring means being effective to absorb high frequency undulations of the disk as it rotates, and means (306h) for hingedly mounting the arms with respect to a support (300) so that the arms may swing together as a unit to accommodate low frequency undulations of the disk as it rotates.

2. A transducer carriage assembly as claimed in claim 1, wherein each first spring means includes a gimbal spring formed of a sheet of resilient material.

3. A transducer carriage assembly as claimed in claim 1 or 2, wherein the second spring means comprises a leaf spring having a portion that is fixed in face to face contact with one of the arms and is flexed to bear against the other of the arms so as to bias the arms towards one another.

4. A transducer carriage assembly as claimed in claim 3, wherein the means for hingedly mounting the arms with respect to the support includes a further portion of the leaf spring that is substantially unflexed when the transducers are in contact with the disk.

5. A transducer carriage assembly as claimed in claim 2, wherein the second spring means and hinge means together comprises a single leaf spring in flat face to face contact with a first of the arms and with the support at spaced locations for hingedly mounting the first arm on the support, the leaf spring being in flat face to face contact with the second arm at a location spaced from the location at which it is in flat face to face contact with the first arm for thereby hingedly connecting the arms together, and the leaf spring being flexed out of a flat unflexed disposition to extend from the location in contact with the second arm and to bear against the first arm at another location thereon so as to provide a force biassing the arms together.

6. A transducer carriage assembly as claimed in claim 5, wherein the single leaf spring comprises, a bifurcated leaf spring which is flat in unstressed condition having a pair of spaced outer legs, a base portion joining the spaced legs together and a central leg disposed between the outer legs, the outer legs being fixed in flat face to face contact with the support, the base portion being fixed in flat face to face contact with the first arm, the central leg being fixed in flat face to face contact with the second arm, and central leg extending from its location of fixing with the second arm to bear the first arm and being stressed thereby out of a flat unstressed condition so that it biasses the arms together.

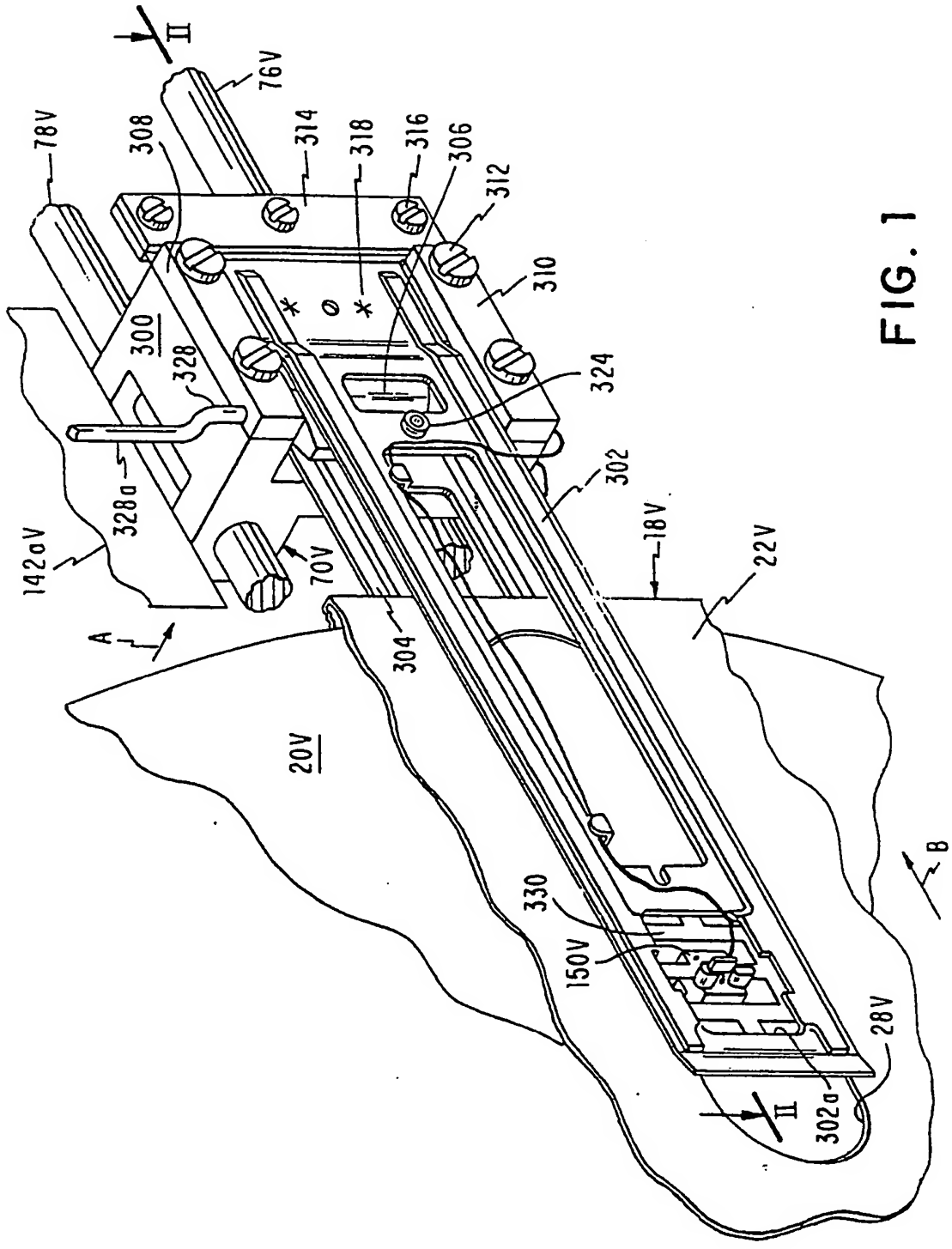

II
76V
78V
308
314
318
316
306
312
310
300
328
324
328a
302
142aV
70V
18V
22V
A
304
20V
330
150V
28V
B
II
302a

FIG. 1

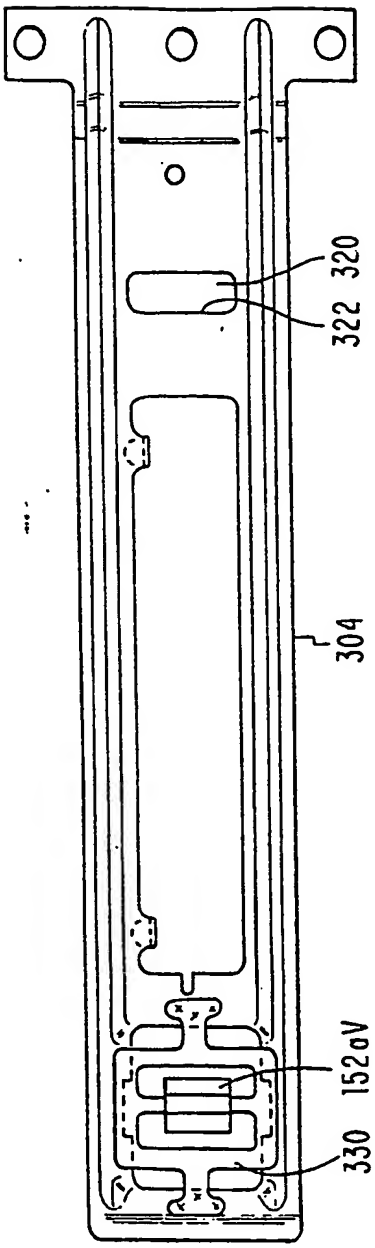

320
322
304
152aV
330

FIG. 4

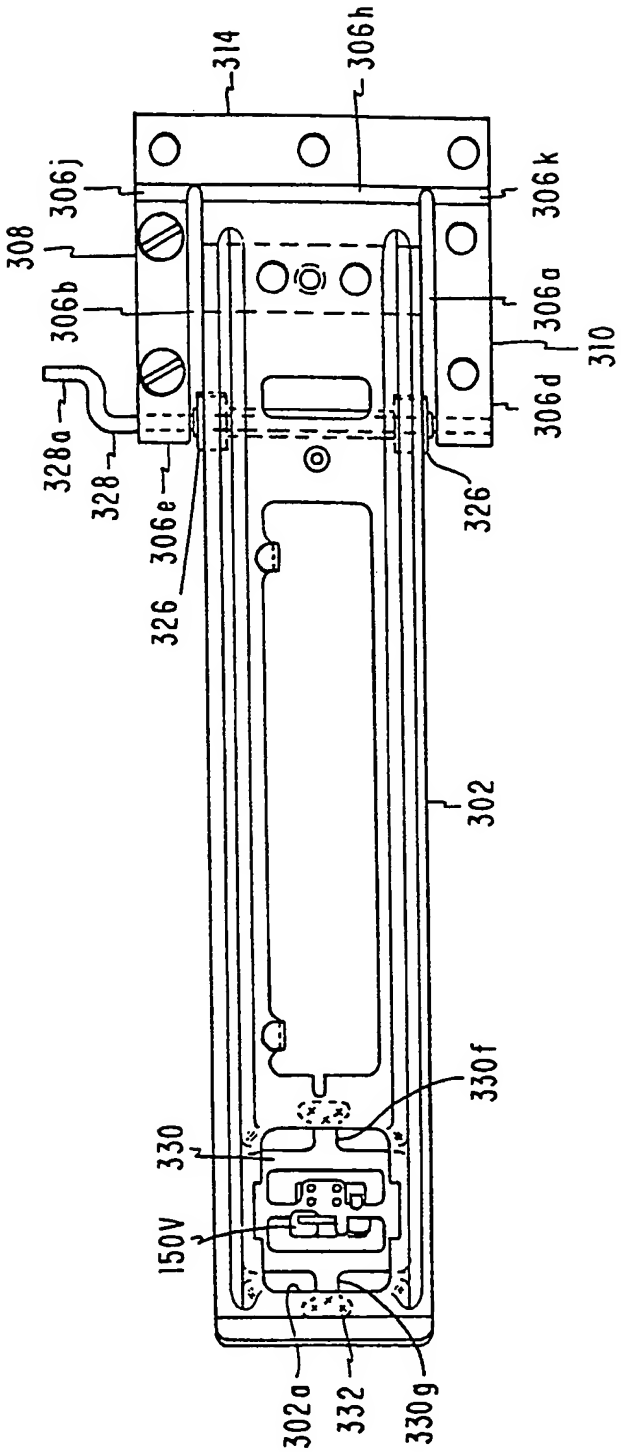

314
306h
306j
306k
308
306b
306a
310
306d
328a
328
326
306e
326
302
330f
330
150V
302a
332
330g

FIG. 3

FIG. 5

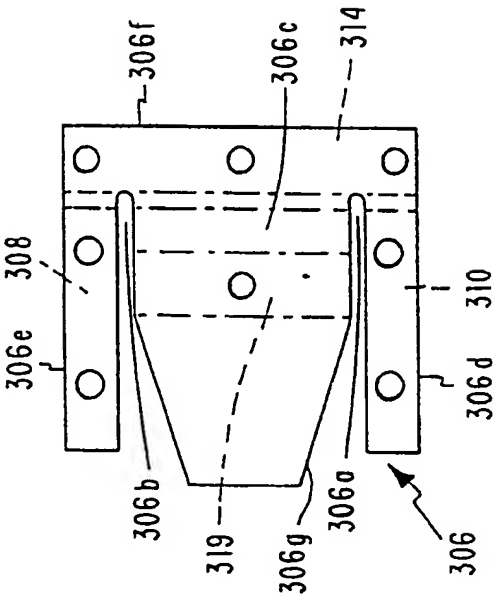


FIG. 2

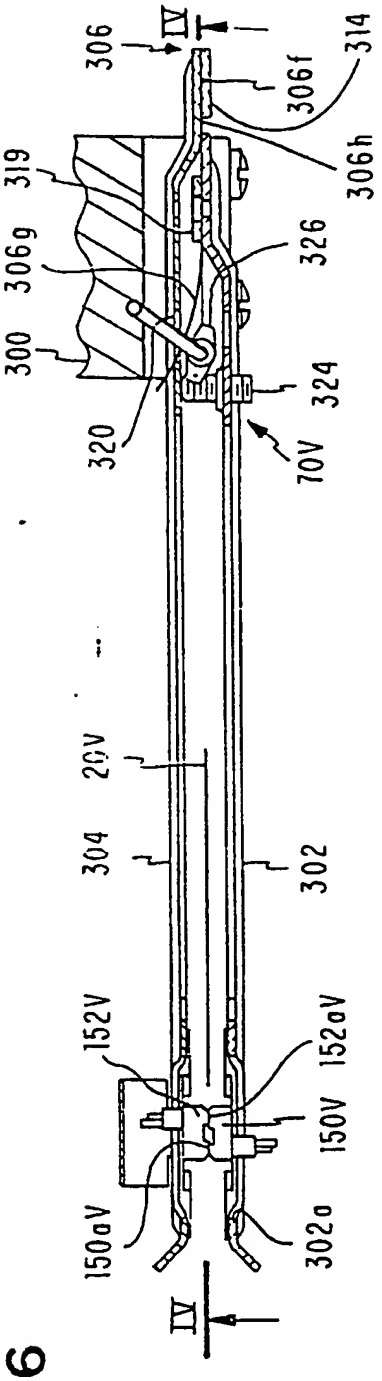
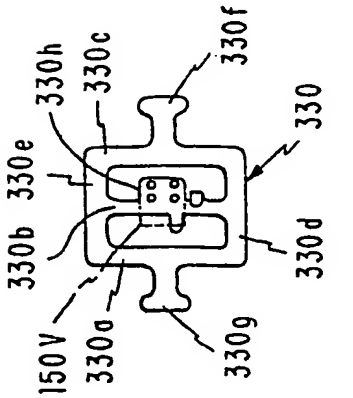


FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application number EP 79 10 4592

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 2 537 657 (D'HUMY et al.) * From column 3, line 5 - column 4, line 68, figures 1, 3 *	1
	US - A - 3 702 997 (JAMIESON) * Column 2, lines 14-34 and 58-66; figures 1, 2 *	1
	US - A - 3 673 352 (WADA et al.) * Column 4, lines 55-68; figures 4 and 5 *	1
	FR - A - 1 043 503 (LOEWE OPTA) * Page 2, left-hand column, lines 3-41; right-hand column, lines 37-44; figure 2 *	1
	US - A - 3 896 495 (BEECROFT) * Column 7, line 31 - column 9, line 2, claim 1; figures 3a, 3b *	1,2,6
	US - A - 3 060 277 (BAKER et al.) * Column 2, lines 44-51; column 3, lines 46-62; figures 1,2, 3 and 5 *	1
	US - A - 3 593 326 (TURNER et al.) * Column 2, lines 43-65; figures 2,3 *	1,2

CLASSIFICATION OF THE APPLICATION (Int Cl)

G 11 B 21/20
5/58

TECHNICAL FIELDS SEARCHED (Int.Cl)

G 11 B 5/58
5/55
5/012
21/20
21/08
21/10
5/48
5/60
5/54

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

[X] The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	02-04-1980	FUX

EPO Form 1503.1 06.78

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EUROPEAN SEARCH REPORT

EP 79 10 4592

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	IBM TECHNICAL DISCLOSURE BULLETIN vol. 16, no. 5, october 1973 Armonk NY US R.B. WATROUS: "Magnetic head suspension", page 1428 * Page 1428, lines 1-3 and 14-18; figures *	1,6

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

EPO Form 1503.2 06.78